Name _____

DNA Replication Simulation

Deoxyribonucleic acid (DNA) carries inherited genetic information in the coded sequence of its nitrogenous bases. It is essential that DNA be exactly duplicated from one cell division to the next to maintain the code of heredity. This duplicative process is termed DNA replication. For replication to begin, the DNA double helix must be unwound and separated into two single-stranded patterns of nucleotides called templates. Complementary DNA nucleotides are brought to each template, where hydrogen bonds form to link the nucleotides of the new strand to the template. The new, antiparallel strands grow in a 5'-to-3' direction, as opposed to the 3'-to-5' template. DNA replication produces two double-stranded molecules from one initial molecule. Because the new DNA double helix conserves half of the original double helix, this is known as semiconservative replication.

Assembly

Use the key in the table below to assist you in replicating your current DNA molecule.

Kit Component	***Part of DNA molecule***	***Quantity Needed***
White beads	Deoxyribose sugar	30
Red beads	Phosphate group	30
Orange beads	Adenine (A)	9
Green beads	Guanine (G)	6
Blue beads	Cytosine (C)	6
Yellow beads	Thymine (T)	9
Clear connectors	Hydrogen bonds	15

To create another 30 nucleotides:

1. Attach a phosphate group (red bead) to the 5' position of the deoxyribose sugar (white bead)
2. Now attach any one of the four nitrogenous bases (adenine-orange, guanine-green, cytosine-blue, thymine-yellow) to the 1' position of the same sugar.
3. Separate the 30 nucleotides you created into 4 groups according to their nitrogenous bases (orange, green, blue, yellow)

Replication

Now you are going to model the semiconservative replication of your DNA molecule.

To prepare your original DNA molecule for replication, follow the directions below:

4. Place the 5' end of the upper strand and the 3' end of the lower strand on the left. The 3' end of the upper strand and the 5' end of the lower strand should be to the right. (see Figure 1)
    - Remember, in your model, the 3' position is the top "peg" and the 5' position is the bottom "hole" on your white bead
5. Beginning on your right, unsnap the hydrogen bonds between the first 5 pairs of nitrogenous bases and separate the two single strands (see Figure 2)

To continue replication, you are going to add the appropriate nucleotides, using the original strands of DNA as a template. Remember, replication occurs in a 5'-to-3' direction off a 3'-to-5' template.

Follow the directions below to add complementary nucleotides to the upper template in order to create what is known as the leading strand (see Figure 2):

6. Starting at the 3' end of the upper strand, add complementary nucleotides
    - Remember to pair adenine with thymine (and vice versa) and guanine with cytosine (and vice versa)
    - Make sure the strand you are creating is positioned antiparallel to the nucleotides on the template strand
7. Place hydrogen bonds between the nitrogenous base pairs
8. Attach the 5' phosphate group of each new nucleotide to the 3' peg of the last sugar on the growing strand
9. Continue adding nucleotides until the template separation point is reached
    - Notice that the leading strand replicates continuously

Follow the directions below to add complementary nucleotides to the lower template in order to create what is known as the lagging strand (see Figure 2):

- Notice replication still occurs in a 5'-to-3' direction off the 3'-to-5' template, but in order for this to happen on the other strand, replication moves away from the separation point
- Thus the lagging strand must replicated in short, discontinuous segments to keep pace with the separating template strands

10. Bring the first complementary nucleotide to be attached to the lower strand to the 3rd nucleotide from the 5' end of the bottom template
11. Replicate a short nucleotide segment by bonding the next 2 nucleotides to the right in an antiparallel manner
12. Attach the 5' phosphate group of each new nucleotide to the 3' peg of the last sugar on the growing strand
13. Move up to the 5th nucleotide on the template and attach its complementary nucleotide
14. Continue pairing the next two bases to the right until the first fragment of the new DNA nucleotides is reached
15. Attach the 5' phosphate group of one segment to the 3' peg of the sugar on the other segment

Continue replication by "unzipping" the next 5 nucleotides of the original DNA strand and repeat steps 6-15.

Finish the replication process by repeating steps 6-15 again for the remaining 5 nucleotides. (see Figure 3)

Finally, compare the two new DNA molecules.

1. Are the two new DNA molecules single or double stranded?

2. Are the strands of each molecule parallel or antiparallel?

3. Which nitrogenous bases pair up with each other?

4. When compared to each other and your original DNA molecule, are the new DNA molecules identical or different?

5. Replication of the new DNA strands ALWAYS occurs in what direction? (*Hint: Think #s*)